

UV LED for IML, IMD & Plastics Decoration

Competing Today While Preparing for Tomorrow



Franklin, TN

June 3, 2019

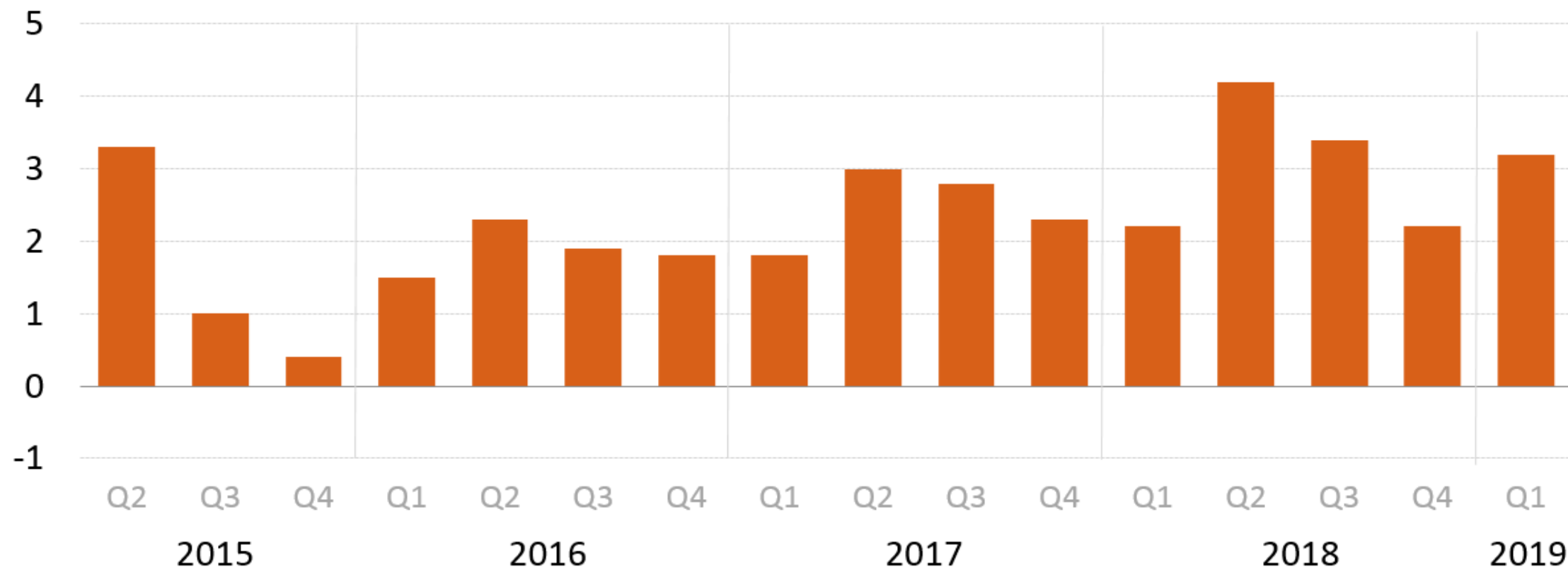


Eminence UV
SHINING LIGHT ON BIG IDEAS

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US Real GDP as % change from preceding quarter



Source: *Gross Domestic Product, First Quarter 2019 (Advance Estimate)*, US Bureau of Economic Analysis, April 26, 2019.¹

US Real GDP strong

■ Growth contributors¹

- Personal consumption
- Private inventory investment
- Exports – *imports actually decreased for previous quarter*
- State and local government spending
- Nonresidential fixed investment

■ Manufacturing contributions²

- Consistently more than 10% of US GDP
- More than 8% of all US employed population in 2017

A strong manufacturing sector creates a clear path toward economic prosperity.³

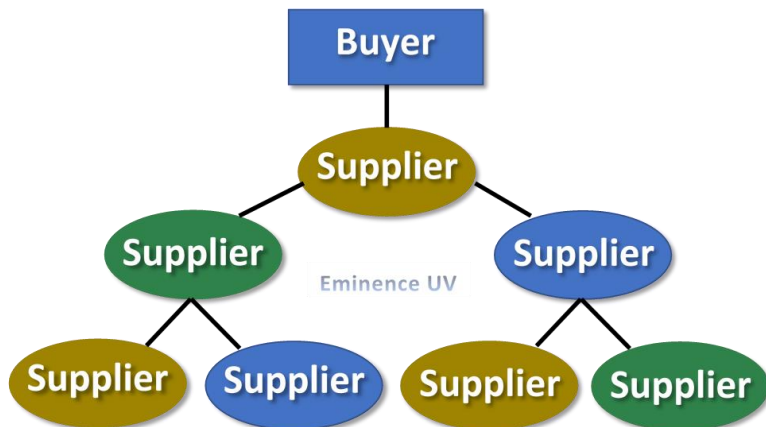
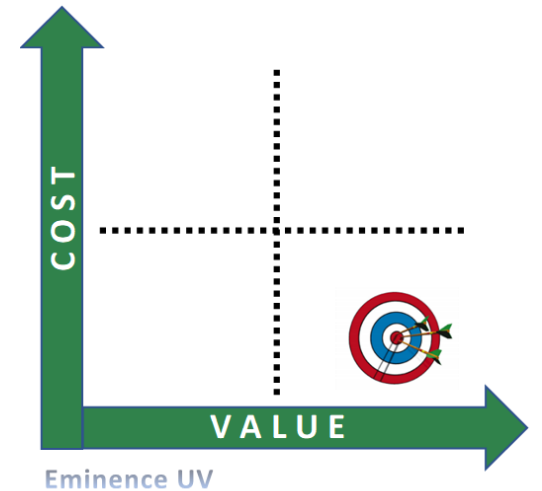
Drivers of manufacturing competitiveness (ranked in order)³

1) Talent

2) Cost Competitiveness

3) Productivity

4) Supplier Network



Skilled labor shortage²

■ Reality

- 6 out of 10 open skilled production positions unfilled today
- 4.6 million manufacturing jobs will become available over next decade
- Nearly 2.4 million positions expected to go unfilled

■ Causes

- Shifting skill set due to advanced technology and automation
- Students and parents negatively view manufacturing industries
- Baby boomer retirements



Skilled labor shortage



51% of executives cited maintaining or increasing production levels to satisfy growing customer demand as the biggest challenge arising from not filling open jobs in the next three years.²

Challenges facing manufacturers

- Attracting and retaining top talent⁴
- Keeping up with and utilizing new technologies (market incorporation)^{4,5}
- Cybersecurity⁴
- Global competition⁴
- Attracting qualified leads⁴
- Navigating regulatory hurdles
- Sustainability

Challenges facing manufacturers

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UV LED by Excelitas



Industry is developing new technologies at an accelerated rate without being able to fully incorporate them into existing products or processes.⁵

Competing today while preparing for tomorrow – Managing dual strategies⁶

- **Goal:** maximize present capabilities and develop new ones in anticipation of the future⁶
- **Problem:** a single strategy encompassing both present and future provides the basis for neither running the existing business effectively nor for managing change⁶
- **Reality:** running a business and managing it are not sequential but parallel activities⁶



Competing today while preparing for tomorrow – Managing dual strategies⁶

■ **Today-for-Today:**

Present planning requires strategy – a vision of how to operate now (given core competencies, target markets, and current opportunities) and the role of each key function⁶

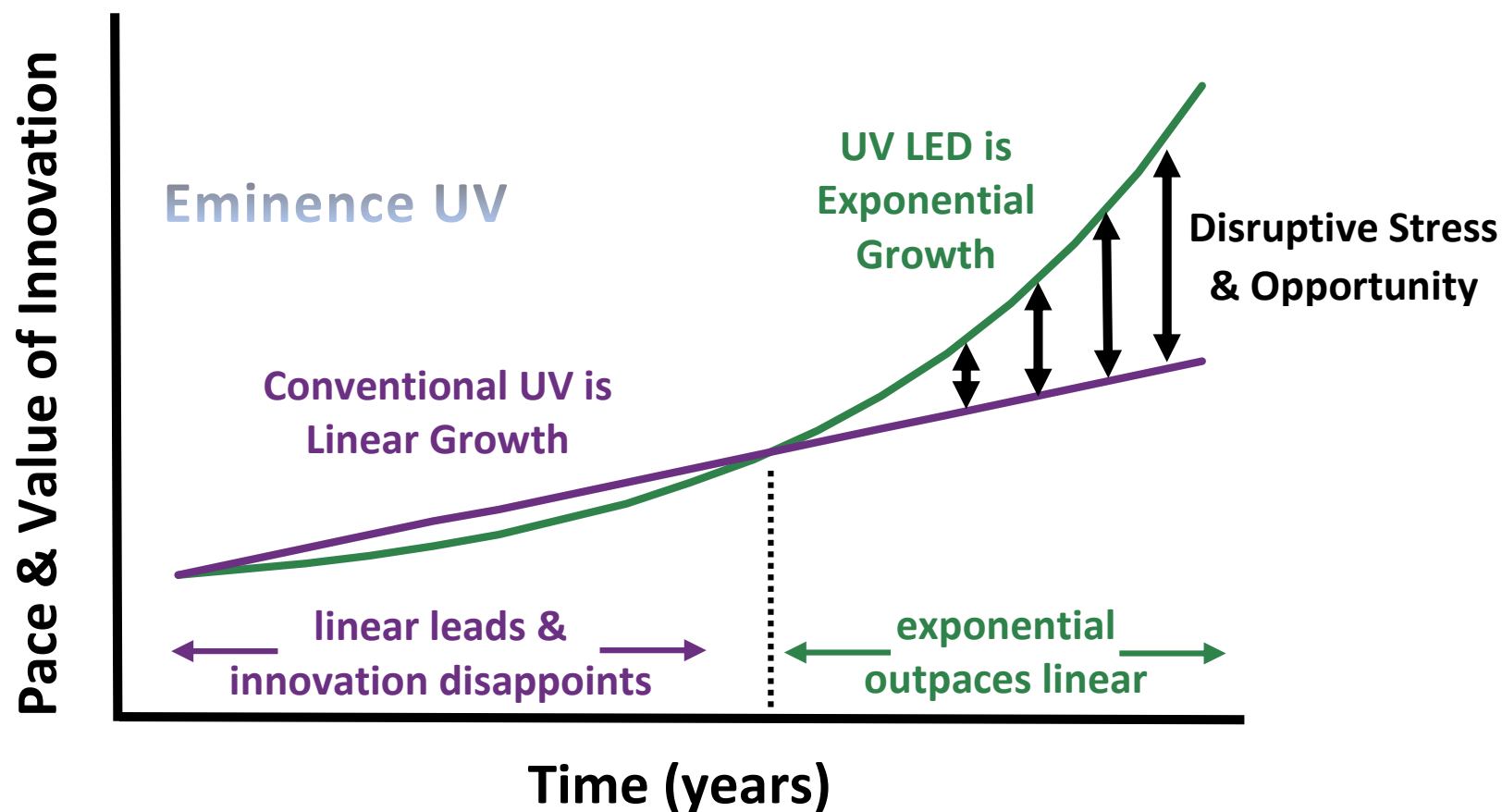
■ **Today-for-Tomorrow:**

Long-term planning is built on a vision of the future and a strategy for getting there...often involves bold moves away from existing ways of conducting business⁶

Planning for today is about managing current activities with excellence; planning for tomorrow is about managing change.⁶

Short-term success is mainly a feature of long-term moves made earlier.⁶

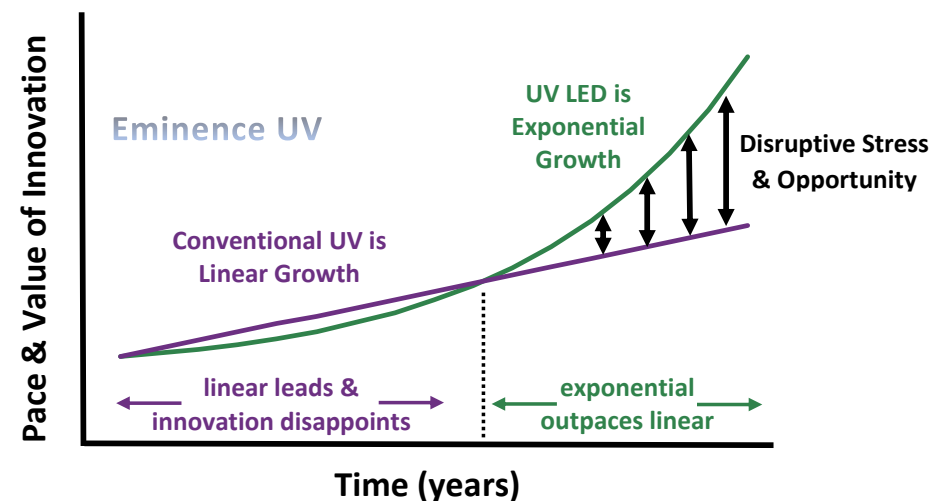
Disruptive stresses increase the value of innovation opportunities



Innovation opportunities are...

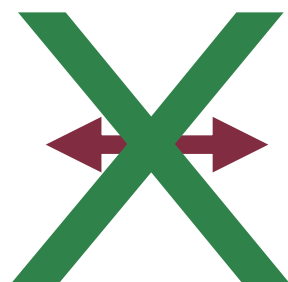


- Doing something that couldn't be done before
- Doing something that is currently being done significantly better

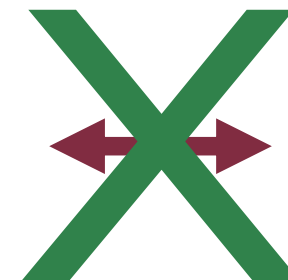


Innovation opportunities are not...

Electrode UV



Microwave UV



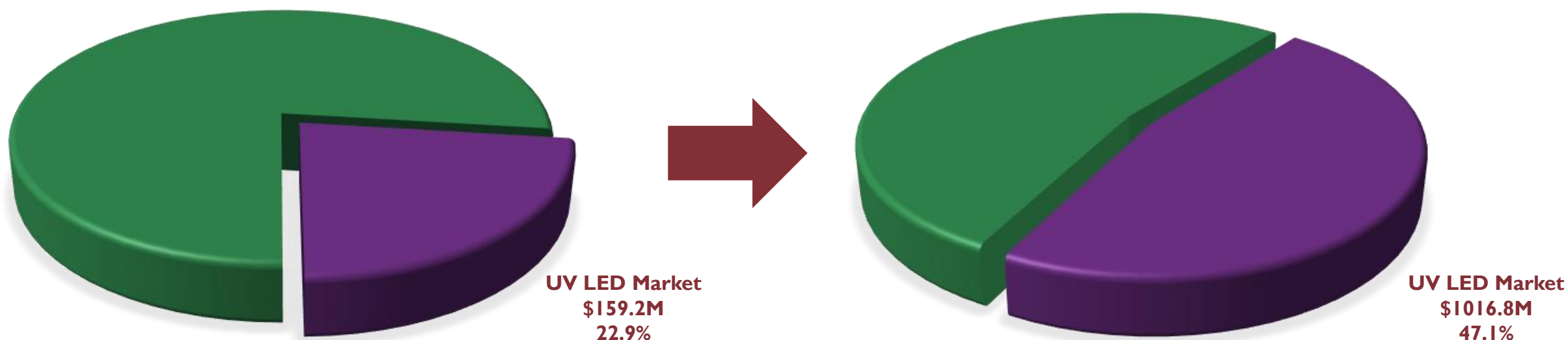
UV LED



***...technology swaps for doing the exact same thing.
This is simply linear growth.***

UV market share - LED vs mercury

Yole UV LED 2018 Report



2017 UV Market: \$690M+

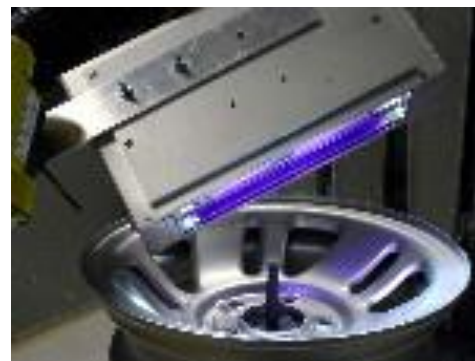
2023 UV Market: \$2B+

*Yole data includes systems for water and air disinfection and sterilization, analytical instruments, medical phototherapy, photocatalytic purification, counterfeit detection, UV curing, and R&D.

Conventional UV curing in IML, IMD & plastic decorating today

■ Printing inks

- Screen
- Flexo
- Offset
- Dry offset
- Pad
- Digital inkjet



■ Coatings

- Primers, hard coats, varnishes
- Spray
- Flow
- Curtain
- Sputtering
- Physical Vapor Deposition (PVD)

■ Adhesives

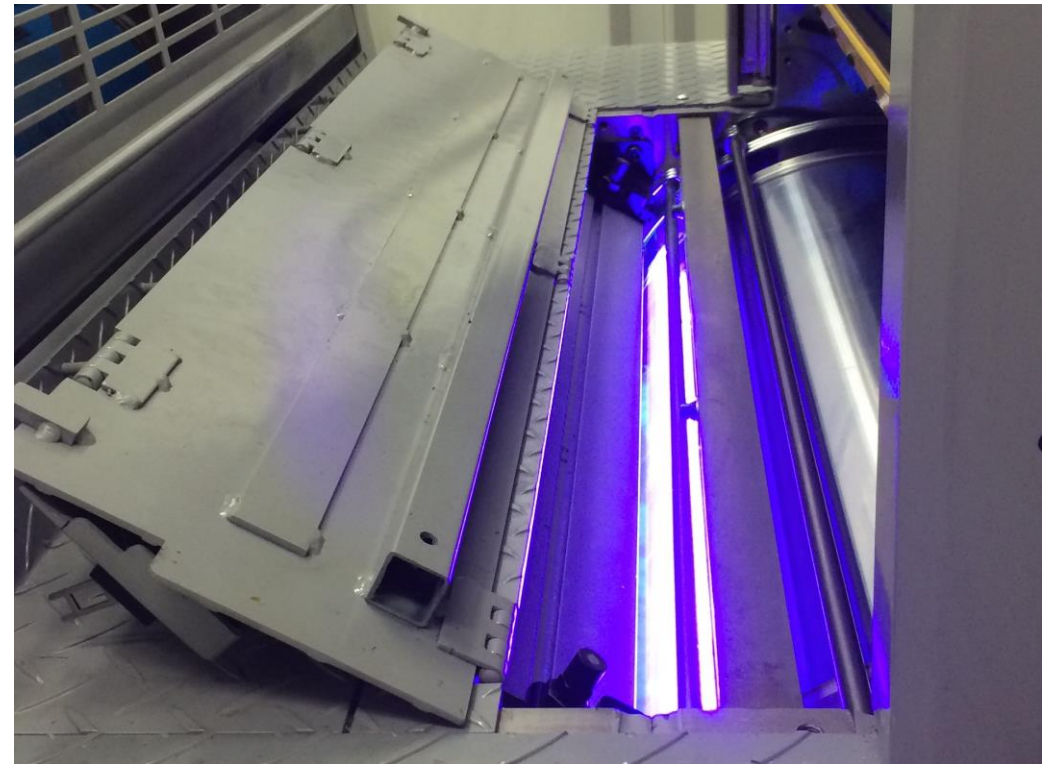
- Structural bonding
- Encapsulants



3D UV Curing Images by ARTomation

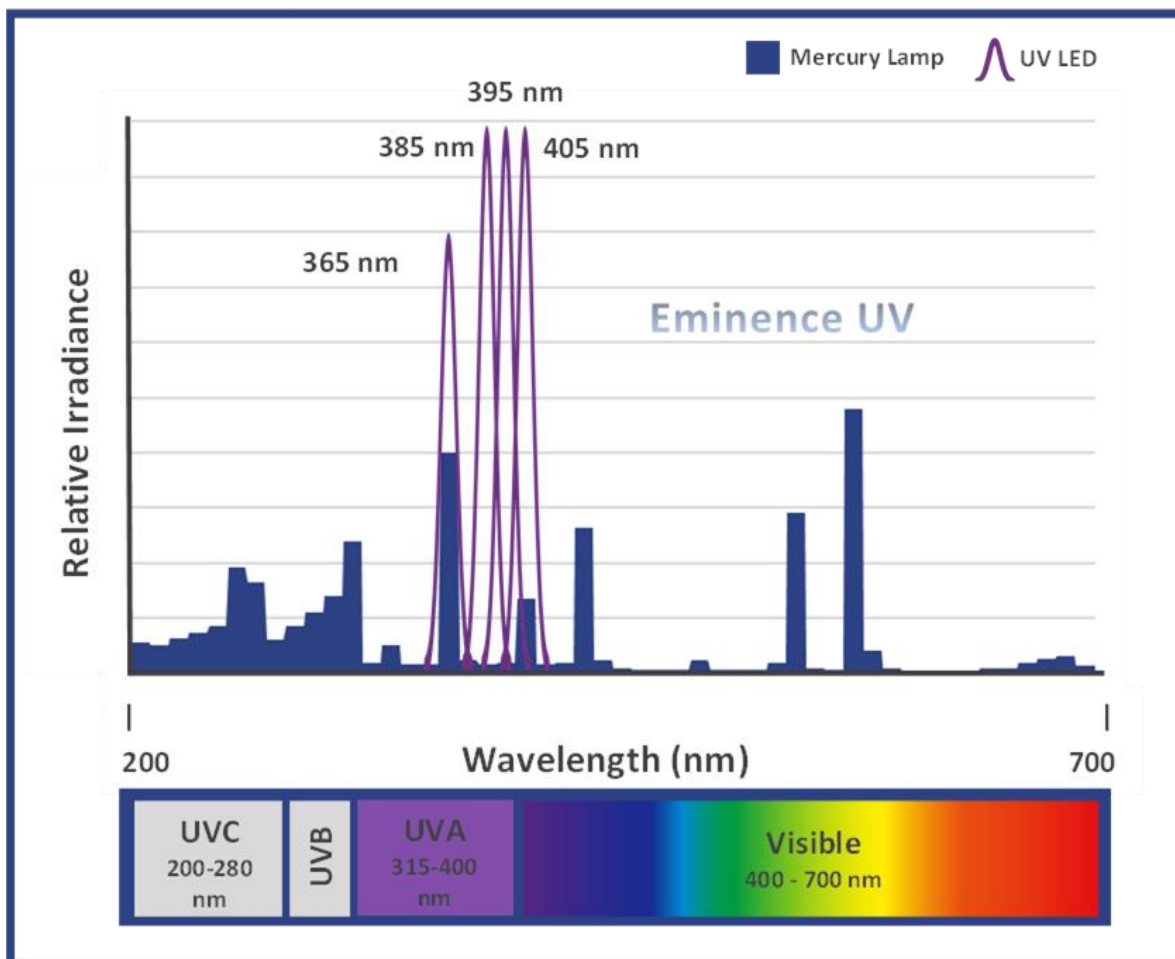
UV LED curing successes in IML today

- LED reduces heat transfer during printing of very thin polypropylene films
- LED increases production speeds upwards of 50%
By comparison, a reduced number of conventional UV lamps MUST be run at low power to minimize heat transfer, avoid film distortion, and create good product. Slows printing process due to amount of energy needed to maintain good cure. Conventional UV and IML is a process running on the edge.
- Energy consumption reduced up to 75% based on need for less total lamps (5-6 down to 1-2) and the more energy efficient nature of LED curing
- Dozen or more operator friendly installations on IML printed film lines worldwide – and growing
- LED specific print innovations in development

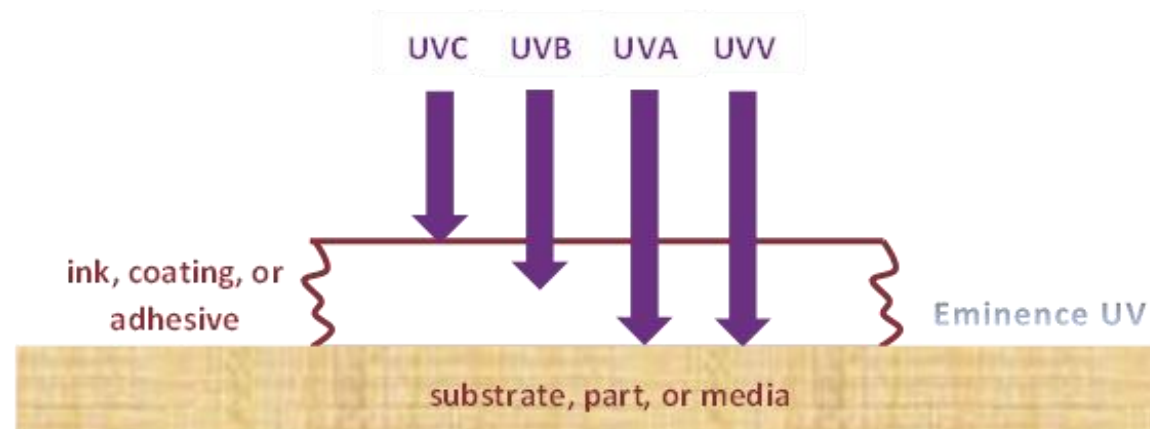


AMS Spectral IML Offset Press Installation

UV LED curing challenges for industrial 3D plastic parts



- Lack of UVC
 - Potential for yellowing of clear coats
 - Potential for insufficient surface cure properties
- No focal length (i.e. >2" offset) for curing at distance and on complicated part profiles
- Chemistry must be modified



UV LED advantages & opportunities for curing plastic parts

■ **Linear Growth –**

Performance & Operation

- Consistent UV output over time
- Reliable
- Long life
- Quiet
- Instant On/Off
- Energy efficient
- No ozone – therefore no exhaust and no conditioned make-up air

■ **Exponential Growth –**

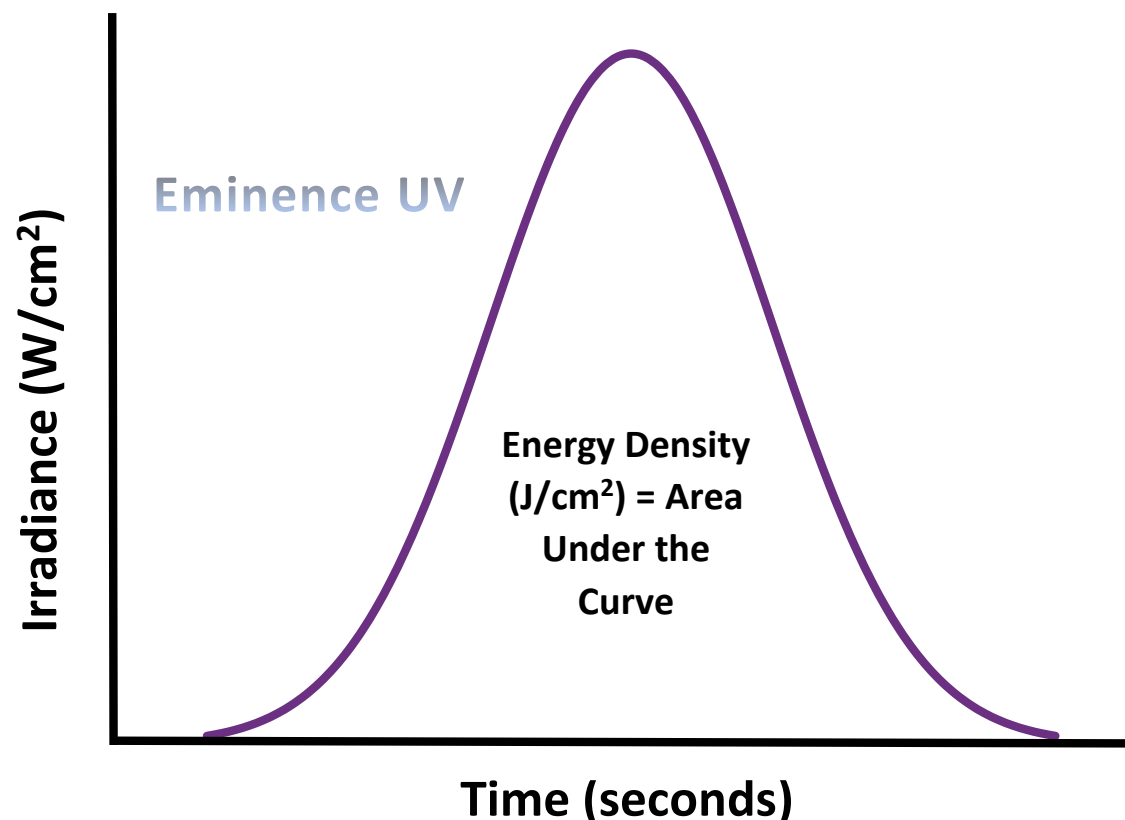
Opportunities due to less heat transfer to parts, substrates, and machine components

- Less scrap, less part warpage, less wear and tear on material handling equipment
- More immediate post cure part processing
- Ability to use thinner walled parts, lower gauge substrates, and new materials

■ **Exponential Growth –**

Opportunities due to unique ways in which LED emits and delivers UV light and offers greater discrete process control

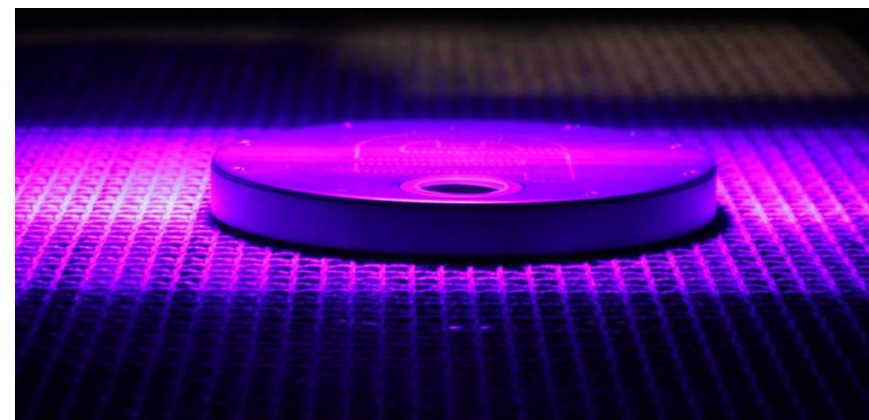
Energy density is the integral of irradiance over time



Irradiance is Delivered Power

Energy Density is Delivered Energy

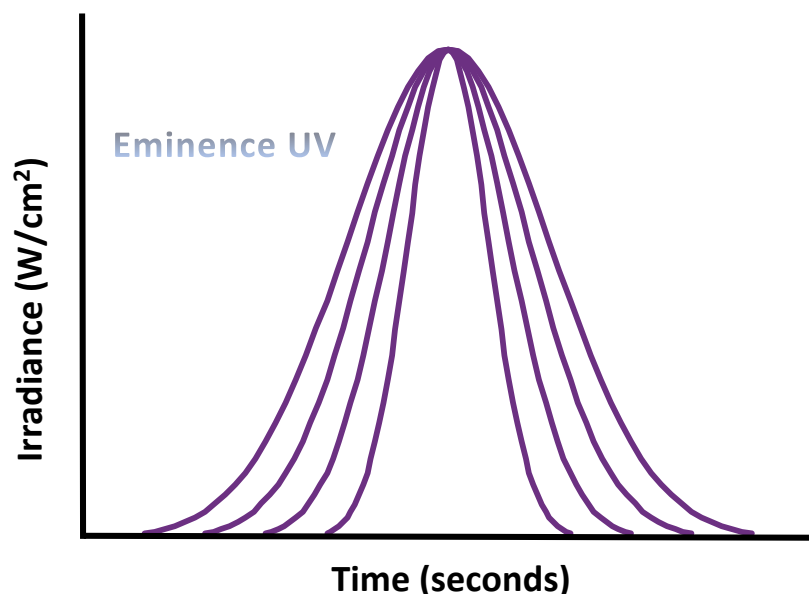
Graph is a representation of a part, sheet, or web passing horizontally (along the x-axis) and underneath a stationary UV source.



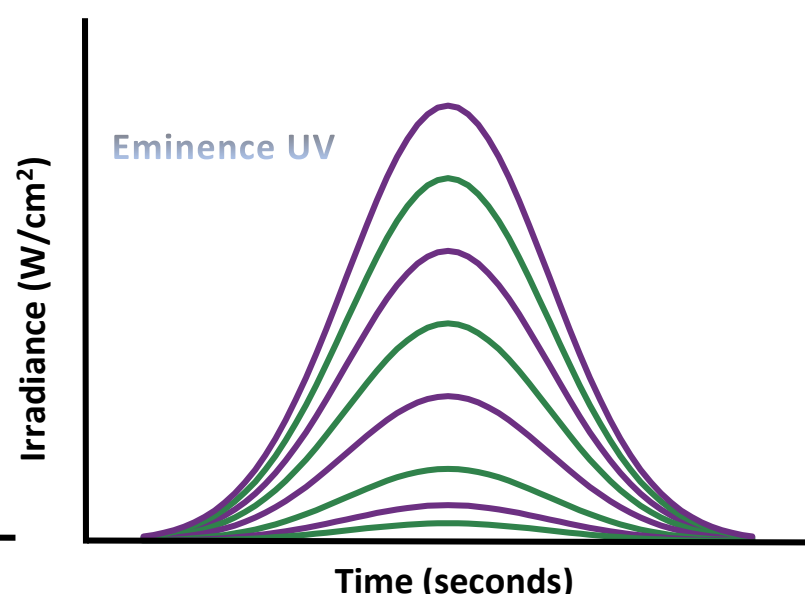
UV Radiometer Image from EIT

Unlimited UV LED irradiance & energy density configurations

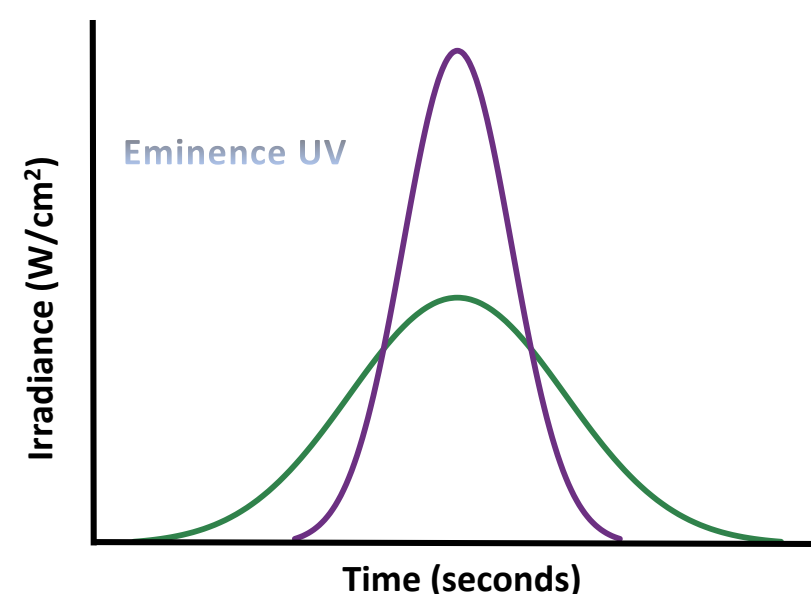
**Same Irradiance
Different Energy Density**



**Different Irradiance
Different Energy Density**

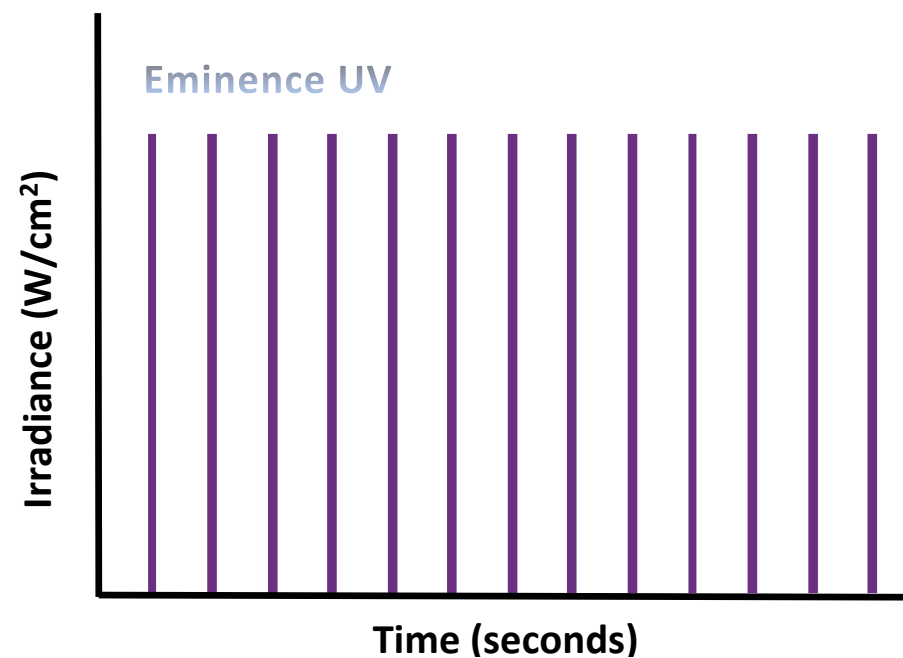


**Different Irradiance
Same Energy Density**

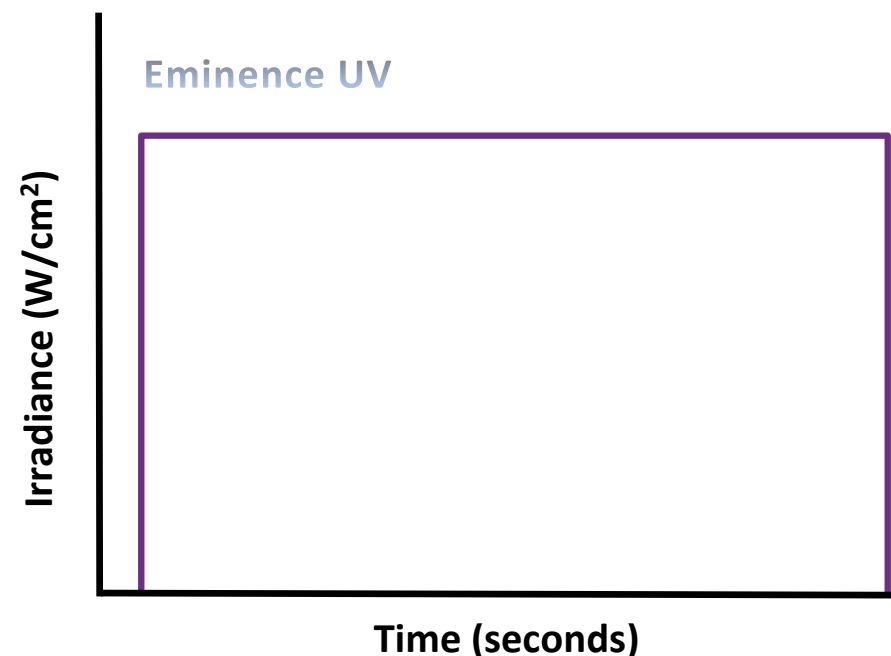


Unlimited UV LED irradiance & energy density configurations

Pulsed Output

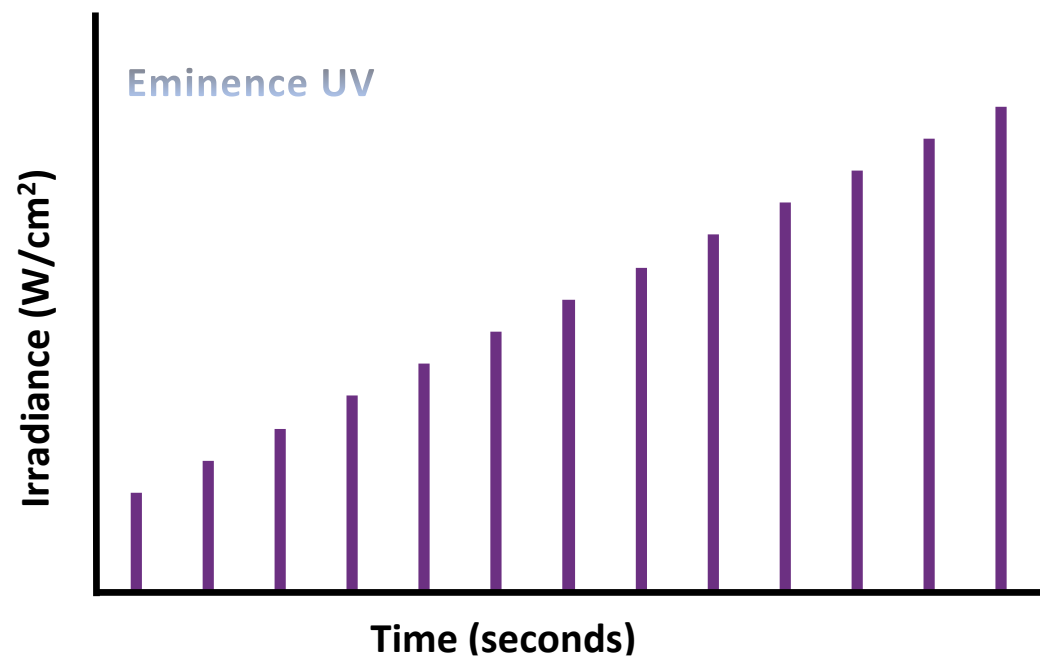


Steady State Output

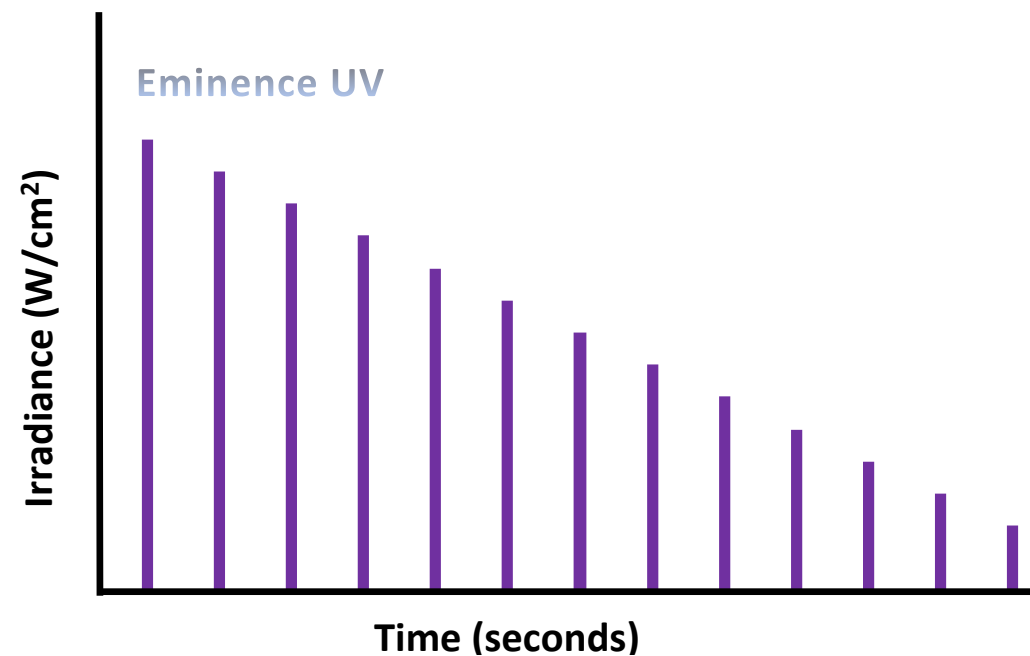


Unlimited UV LED irradiance & energy density configurations

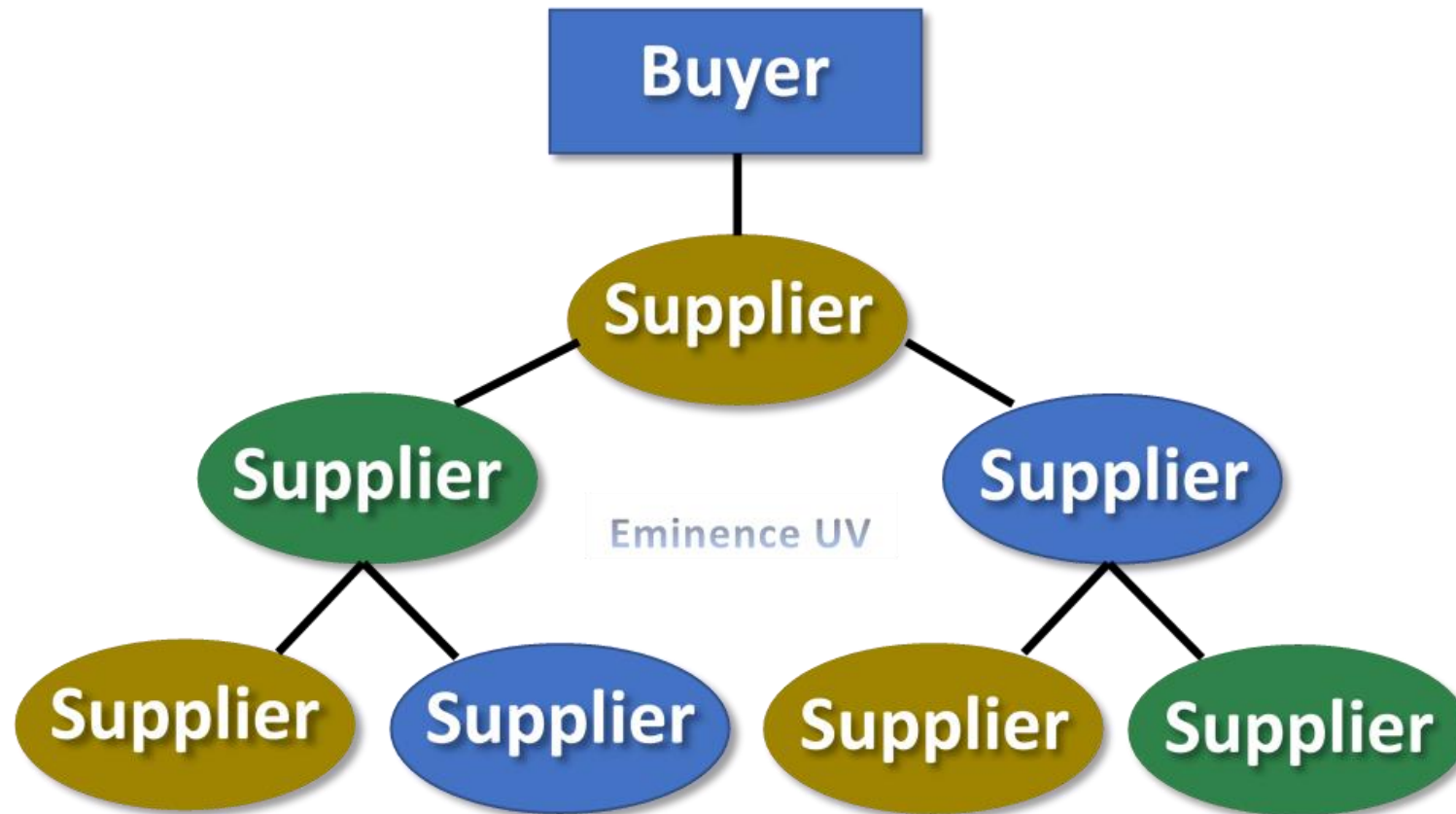
Pulsed: Ramp Up



Pulsed: Ramp Down



Supplier network for developed technologies



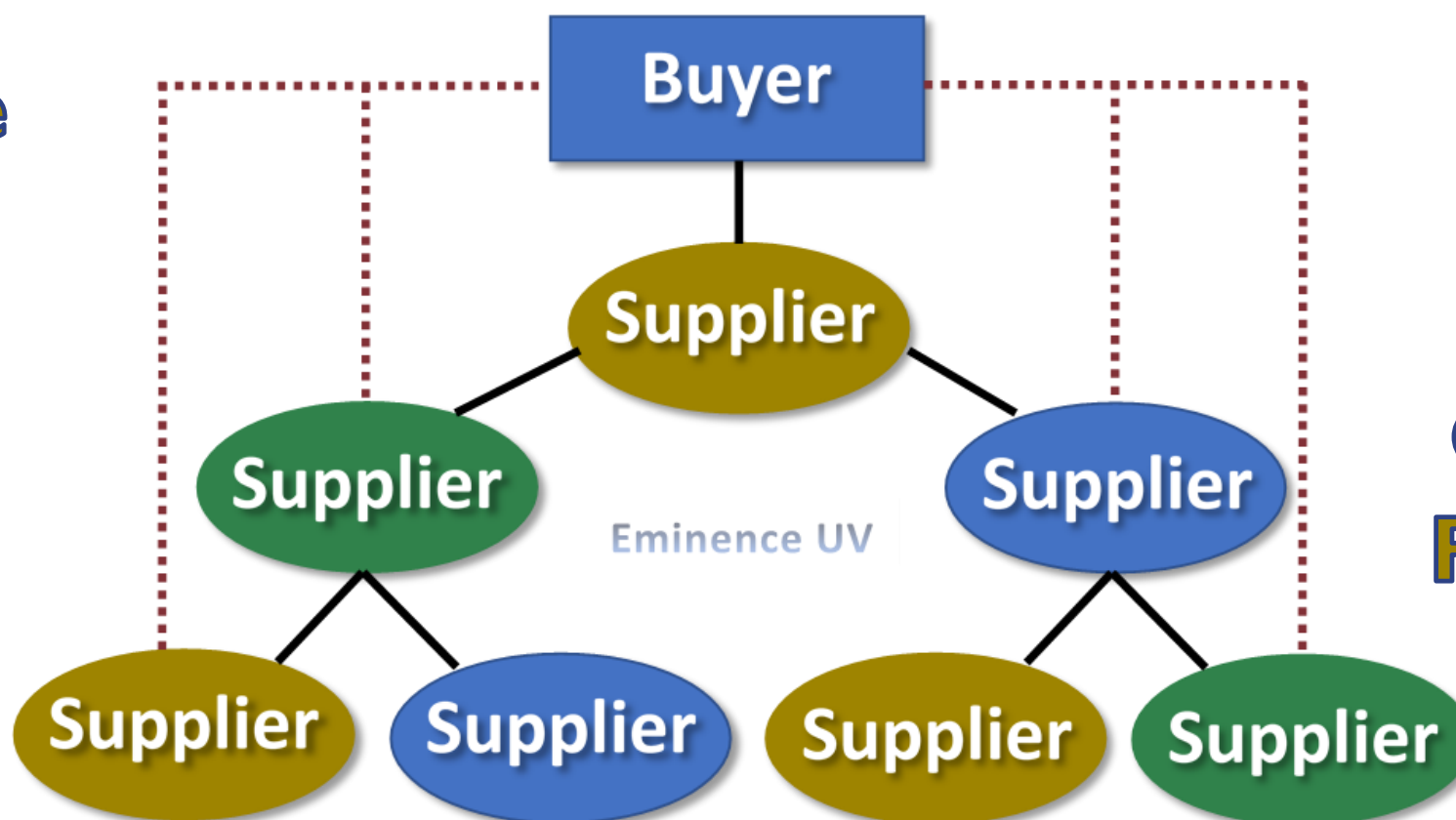
Supplier network for developing & commercializing new technologies

**Machine
Builder**

**UV LED
System
Supplier**

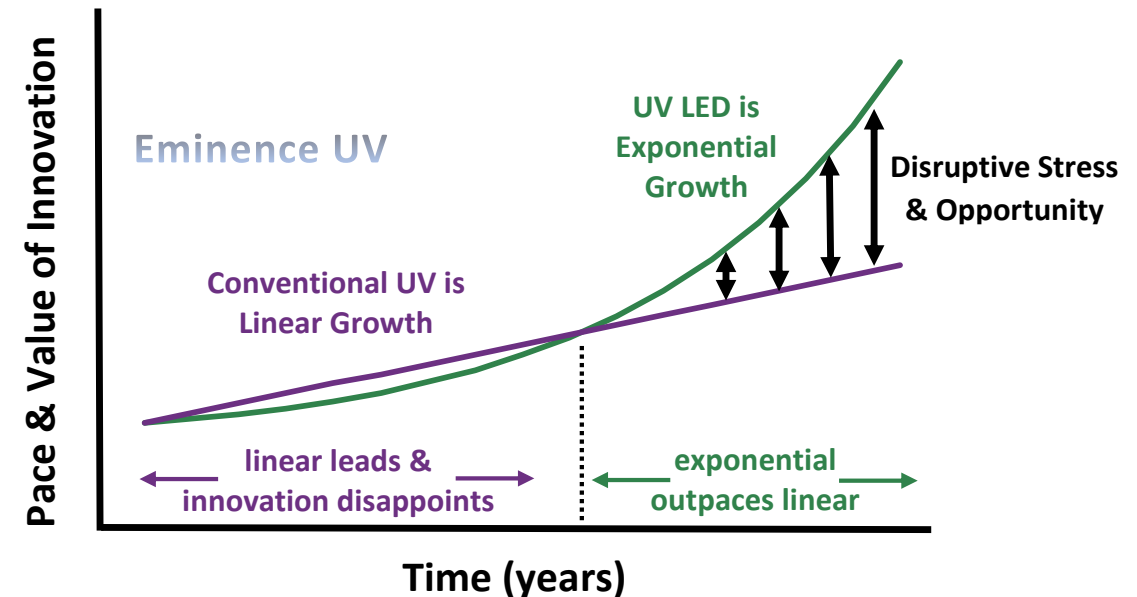
**Substrate
Supplier**

**Chemistry
Formulator**



UV LED - disruptive stress and opportunity driven change⁶

- A company creates industry shifts and puts others in the position of reacting to its initiatives
- Planning is **discovery-driven** rather than simply anticipative
- Managers probe the future by conducting ongoing series of experiments
- For LED, the real innovative opportunities lie in applications that will harness LED output to...
 - create new plastic part designs that cannot be done today
 - enable better ways of processing and decorating plastic parts
- Companies with big imaginations and a willingness to understand the nuances of LED technology will capitalize on disruptive stresses and opportunities to shape the future of plastics decoration





Eminence UV

Thank You!

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